

## GLASS BREAKAGE DETECTION

### FIELD

[0001] The described embodiments relate generally to glass or other ceramic components, such as the cover glass of a display. More particularly, the present embodiments relate to detecting breakage of ceramic components.

### BACKGROUND

[0002] Many devices include ceramic or other relatively brittle components. These components may be vulnerable to damage. For example, smart phones, wearable electronic devices, and/or other electronic devices may include a cover glass for a touch or other display. These cover glasses may be vulnerable to damage. For example, the cover glass may crack or break when the cover glass impacts a surface, such as when the device is dropped.

[0003] This kind of damage may only be recognized by visual inspection. If the user of a device does not notice the damage, the user may continue using the device without seeking repair despite risk of further impairment to the device related to the damage. Even if the user notices the damage, the user may not be aware of the risks. Another party may be aware of the risks, such as a provider of the device, but may not be aware of the damage unless the user informs them. Without awareness, the other party may not have an opportunity to warn the user about continuing to use the damaged device.

### SUMMARY

[0004] The present disclosure relates to detecting breakage in a glass or other breakable external component, such as the cover glass of a display. One or more emitters emit one or more waves that travel via the glass. One or more receivers are configured to receive the waves from the glass. Damage to the glass, cracks for example, interrupts and/or interferes with travel of the waves via the glass. The presence and/or absence of damage to the glass is determined based on whether or not the receivers receive the waves. The location of damage to the glass may also be determined based on whether or not the receivers receive the waves.

[0005] In various embodiments, an electronic device includes an external component; a sensor operable to receive a signal that travels via the external component; and a processing unit, coupled to the sensor, that determines damage to the external component by determining whether the sensor receives the signal.

[0006] In some examples, the external component is optically transparent. In numerous examples, the signal is an optical signal. A wavelength of the optical signal may be outside a visible spectrum.

[0007] In various examples, the signal travels through the external component. The signal may travel through the external component due to internal reflection of the signal within the external component. In other examples, the signal travels on a surface of the external component.

[0008] In numerous examples, the sensor is located adjacent an edge of the external component. In various implementations of these examples, the electronic device further includes an emitter located adjacent a center of the external component that emits the signal.

[0009] In some embodiments, an electronic device includes an optically transparent component; a first emitter

operable to emit a first wave which travels via the optically transparent component; a second emitter operable to emit a second wave which travels via the optically transparent component; first and second receivers operable to receive the first and second waves from the optically transparent component; and a processing unit, coupled to the first and second receivers, that determines a location of damage to the optically transparent component by determining which of the first and second receivers receives the first wave or the second wave.

[0010] In numerous examples, the first and second emitters are located at first opposing corners of the optically transparent component. In some implementations of these examples, the first and second receivers are located at second opposing corners of the optically transparent component. In various examples, the first emitter and the first receiver are embedded within the optically transparent component.

[0011] In some examples, the first and second waves are modulated with different patterns. The first and second waves may be at least one of time multiplexed or frequency multiplexed. In numerous examples, the first wave is an ultrasonic wave.

[0012] In numerous embodiments, a method of detecting damage to a glass component includes emitting a signal that travels via the glass component and determining that the glass component is damaged when the signal is not received. In various examples, the method further includes transmitting a notification that the glass component is damaged to an electronic device.

[0013] In some examples, the method further includes determining a location of the damage based on not receiving the signal and at least one other signal. In various examples, the method further includes determining a location of the damage based on not receiving the signal and at least one other receiver not receiving the signal.

[0014] In numerous examples, the method further includes modulating the signal with a pattern. In these examples, the method may further include emitting an additional signal that travels via the glass component from a different emitter than the signal and modulating the additional signal with an additional pattern that is different from the pattern.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements.

[0016] FIG. 1 depicts an electronic device with a glass or other breakable external component, such as a cover glass.

[0017] FIG. 2 depicts a schematic cross-sectional view of a first example implementation of the electronic device of FIG. 1, taken along line A-A of FIG. 1.

[0018] FIG. 3 depicts the schematic cross-sectional view of the electronic device of FIG. 2 after damage to the cover glass.

[0019] FIG. 4 depicts a schematic cross-sectional view of a first example configuration of components that may be used in an electronic device, such as the electronic device of FIG. 1, to detect damage to a cover glass, taken along line B-B shown with respect to FIG. 2.

[0020] FIG. 5 depicts the schematic cross-sectional view of the electronic device of FIG. 4 after damage to the cover glass.